Space Weather Technical Forecast

Issued on Saturday, 17 August 2024 at 13:04 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1-G2 Likely UTC day of Saturday 17 August. New CME from northwest, imagery awaited.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity at GOES16 rose to Moderate in the past 24 hours, with an M1.3 flare observed from Ex-AR3780 on the southwestern limb at 16/1324UTC. This was later trumped by an impulsive M1.6 from AR3784 at 17/1033UTC. This second event has a EUV dimming associated with it and is considered likely to have produced a CME. Imagery is awaited. AR3785 also produced a late M1.1 at 17/1143UTC.

There are now up to 12 sunspot regions on the visible disc, with Ex-AR3780 no longer visible over the southwestern limb, while a small unnumbered unipolar spot also faded in the northwest. In the northeast, up to two new minor regions developed in the period. AR3784 and AR3790 both showed development and growth of penumbral leading spots in the period. AR3785 and AR3789 showed more marked proliferation of spots generally, but both from a lower base complexity, although the former is perhaps approaching development of a tenuous Mt Wilson delta spot in its leading cluster. Probably the most nominally potent group on the disc remains AR3784, which is essentially on large Mt Wilson delta. Its span has reduced compared with recent analyses, and this has seen its Zurich class change from an Ekc to a Dkc, but its risk of flaring is felt to remain similar.

There were numerous minor filament lift-offs identified in the past 24 hours - either from high latitudes or likely sufficiently far west to not have Earth-directed components. Modelling for a minor dimming event in AIA211 from the vicinity of AR3784 at 17/0500UTC is awaited. No new Coronal Mass Ejections (CMEs) were therefore in evidence, although note that imagery is also awaited for the M1.6 event from AR3784.

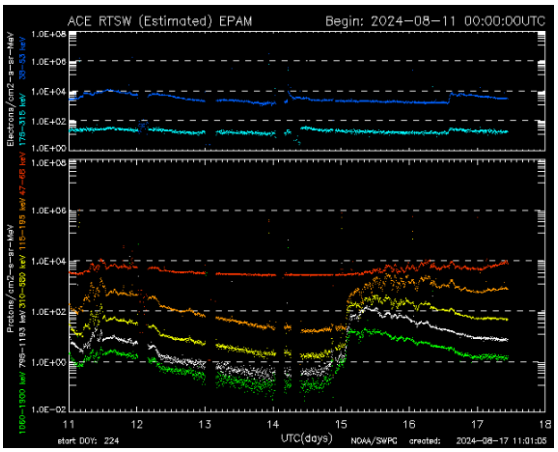

Figure 0: Past seven days of ACE EPAM LEMS measurements, which show a possible developing rise in the past few hours that may be a precursor to the 14 August X1.1 CME arrival at Earth.

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Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE at L1 were reflective of a slow regime. ACE EPAM LEMS is perhaps now showing a very gradual uptick across all energies and this may be a precursor to any CME arrival.

The solar wind speed showed a slight dip from background levels of 350 to nearer 325km/s. The solar wind density fell from early highs near 10ppcc to single figures. The IMF was stable, with a peak value of 7nT and with an erratic north-south component ranging between +6 and -5nT. An SSBC occurred at the very start of the past 24 hours, however the phi angle has since been stable with a positive orientation throughout (away from the Sun).

The net result of the above solar wind measures was for provisionally Quiet geomagnetic indices, peaking with a Kp '2+' in the 12-15UTC interval.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 remained at Background levels.

High energy electron flux (greater than 2MeV) observed at GOES16 was at mostly Normal Background levels. The 24-hour fluence was below the Active threshold, with 1.59e6 integrated pfu observed at 17/0001UTC, on a declining, then level trend.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is Expected, with a daily Slight Chance of isolated X-class flares, perhaps most likely from AR3784 in the northwest. This risk is judged constant throughout, with significant departing regions (Ex-AR3780) perhaps in some way compensated for by the weight of numbers of east limb arrivals.

Solar Wind /Geomagnetic Activity: A faint, partial halo CME occurred due to the X1.1 flare at 14/0640UTC. This is now slightly overdue (but still within the stated margin of error) and is forecast to arrive within the remainder of day 1 (Saturday 17 August). The strength of this is low confidence, with the main geomagnetic activity likely with any subsequent magnetic cloud. This has the potential to be further enhanced by the fast wind of CH58/- on the north-disc, however in itself this is most likely to remain north of the ecliptic.

Mainly Quiet geomagnetic activity is therefore expected at first, giving way to Likely G1/G2 Minor to Moderate Storm on day 1 (Saturday 17 August) due to the X1.1 CME arrival. There is now a decreased Slight Chance of this event reaching G3 Strong (Kp 7) Storm. Activity should then revert to Quiet later on day 2 (Sunday 18 August).

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain at Background, but with a Slight Chance of breaching S1 Minor solar radiation storm level should any notable flares occur from either Ex-AR3780 on the western limb or AR3784 in the northwest.

The high energy electron flux is forecast to continue its current subdued diurnal oscillation, with the 24-hour fluence remaining below the Active threshold (1e8 integrated pfu). Confidence in this state of affair's continuation falls in the wake of the CME.

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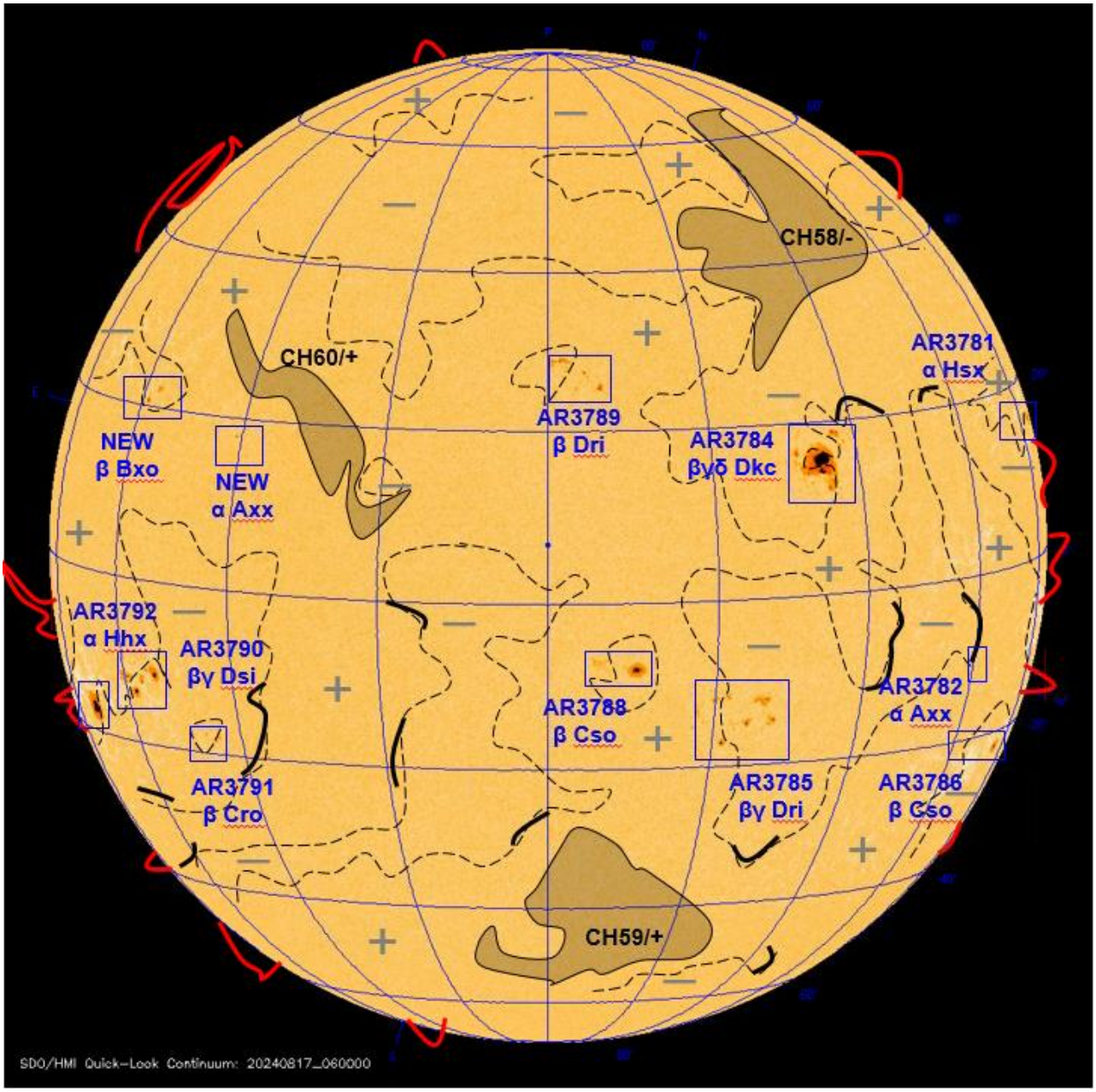
Figure 1. Solar Analysis Valid 17/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No fast winds (directly) feature in the four-day forecast and only one CME, although note that the 17/1033UTC M1.6 from AR3784 is likely to have produced a new CME and imagery is awaited. Modelling for a EUV dimming from AR3784 at 17/0500UTC is also awaited, although this earlier event is judged as likely too far west for Earth impacts.

This CME was visible as a faint, partial halo CME associated with the X1.1 flare at 14/0640UTC. This has been assessed as having an Earth-directed component, now slightly overdue but still most likely arriving at Earth within the remainder of the current UTC day, and perhaps relatively soon given ACE EPAM LEMS perhaps showing a very gradual turn upwards across the energy spectrum.

Given the relatively slow speed of the CME, the initial (shock) impact may be rather limited, with the majority of the geomagnetic activity most likely with the subsequent magnetic cloud. This should still peak within the first half of the current UTC weekend, but effects are perhaps now relatively more likely continue into Sunday 18 August given the delayed onset. This CME is likely to have interacted with the fast wind emanating from negative polarity coronal hole 58 en route to Earth, and while the most likely case is that the fast wind itself should pass north of the ecliptic plane (as on last pass), this is marginal. Earth is very slightly further above the solar equatorial plane on this rotation relative to last (making northern solar hemisphere features potentially more aligned), however the feature is of a less well-connecting polarity at this stage of the cycle, and the fast wind persists in remaining north of Earth on the latest MOSWOC Enlil runs.

Initial Quiet geomagnetic activity should soon rise to Likely G1/G2 on Saturday 17 August, with a gradual tailing off then expected late in the UTC weekend to leave the new working week Quiet once again. There is a Slight Chance of G3 Strong geomagnetic storm activity owing to complications in the analysis (pollution of the halo from a northwest limb CME) and also any low confidence interaction with a large and presumably intense (from EUV appearances) coronal hole on the northwest disc.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	70	50	1	1
Strong	G3	No	10	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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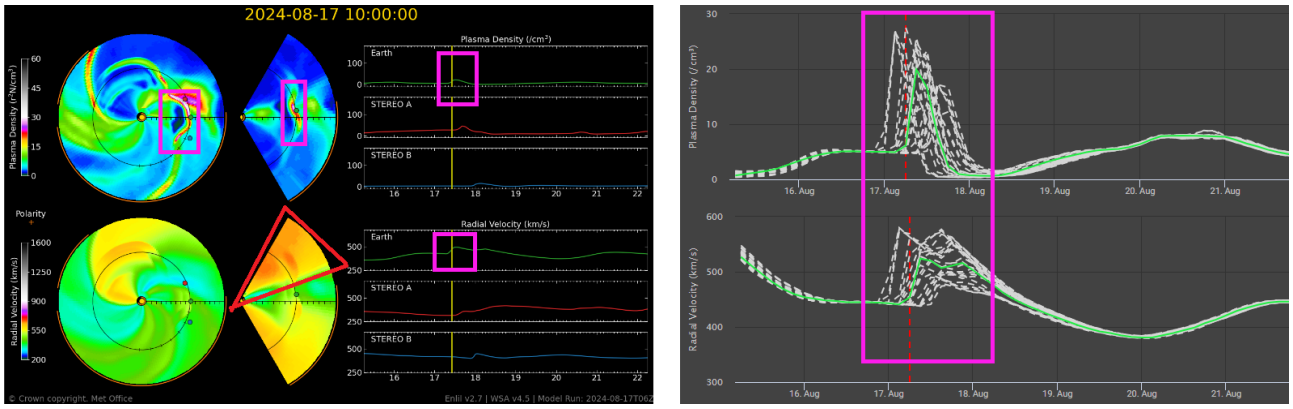
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
14/1400	Partial	X1.1 flare	AR3784, N centre	610km/s	Imminent	High probability of arrival, now overdue but considered imminent.

Figure 2: Latest MOSWOC Enlil and ensemble (badge time 17/0600UTC), showing the simulation paused at the 1AU crossing of the 14 August CME, with various guises boxed in magenta. This is now overdue versus the deterministic run, but is well within the scope of the expecte margins of error. Also note the red polygon on the MOSWOC Enlil speed side slice, showing CH58/- as passing comfortably above the ecliptic plane, but perhaps acting to slightly speed the passage of the main body of the inbound CME.



Radio Blackouts - X-Ray Flares:

The Sun is currently showing two main clusters of sunspot groups that are diametrically opposite each other - one such cluster is now crossing the western solar horizon and the second is progressive rotating onto the east. This is expected to in some way compensate for the recent loss of active AR3780 over the southwest, as AR3790 and the returning Carringtons for many of the regions Ex-3765-70 are progressively due over the limb inside 36 hours' time.

While many of the more complex groups lie on each limb at present, there are exceptions. Firstly the minor but increasingly congested AR3789 and AR3785 in the centre-west, but perhaps most notably AR3784, which still consists of one large Mt Wilson delta spot. While still a nominally threatening region, its span has reduced in recent hours to form a Zurich Dkc as opposed to an Ekc. There are also some signs that this group is becoming more symmetric in its main penumbral spots, which on its own would hint at a reduction in likelihood of the largest flares, however another trend recently seen here has been the development of new leading spots which would urge caution in writing the group off. Activity from this group will probably be episodic as the delta reconfigures - with differential rotation ensuring some shear is present between its two component parts.

All considered, M-class flares remain Likely in the four days, with an ongoing Slight Chance of X-class.

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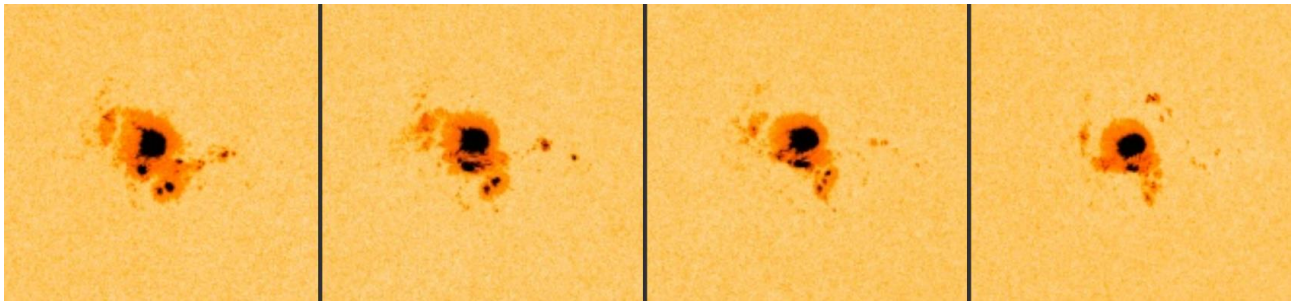
X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	No	20	20	20	20

Figure 3: HMIIF imagery sequence of AR3784 at 00UTC each day from 14 to 17 August inclusive (left to right). The first image immediately precedes the X1.1 flare. Areal decrease, a tendency towards greater symmetry and a reduction in the number and intensity of surrounding spots have all taken place, but the inherent instability of what remains a Mt Wilson delta and the fact that the magnetic neutral lies east-west likely still make this a group of note.



Solar Radiation Storms - (High Energy Protons):

The daily risk of solar radiation storms is held at a Slight Chance throughout the four-day period. No recent enhancements have been seen at GOES18, despite recent M and X-class X-ray flare activity from the western solar hemisphere, and for this reason the daily risk has been revised downwards slightly relative to raw values.

The level of risk of S1+ is essentially largely a trade off between a now-decreasing contribution from Ex-AR3780 (and perhaps a very small contribution from Ex-AR3777), versus the increasing component from AR3784 in the northwest. While there are numerous eastern solar hemisphere groups including AR3790, these do not contribute significantly in the period.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	20	20	20	20
Very Active	≥ S3 *	No	5	5	5	5

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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High Energy Electrons Event (≥ 2MeV):

High energy electron flux is expected to continue its current muted diurnal trend in the near-term, in the absence of any significant mechanisms to alter this state of affairs and with no coronal hole fast winds due in the four days. Confidence in the continuation of this behaviour in the wake of the X1.1 CME on Saturday 17 August should fall, perhaps giving an eventual Slight Chance of Active 24-hour fluence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^{8}$**	No	1	5	10	10
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	1	1	1	1

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